USDA United States Department of Agriculture

Forests

A presentation in support of the interagency panel
"Observing Gaps and Needs"
in the context of the upcoming 5th National Climate Assessment (NCA5)

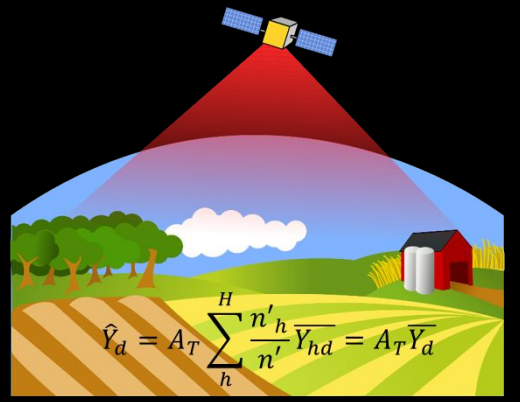
USGCRP's Integrated Observations Interagency Working Group Monthly Seminar Series
Earth Observation Needs for Land Use and Land Cover, Forests, and Agriculture
June 16, 2022 | 4:00 PM - 5:00 PM ET

Dr. Karen Schleeweis

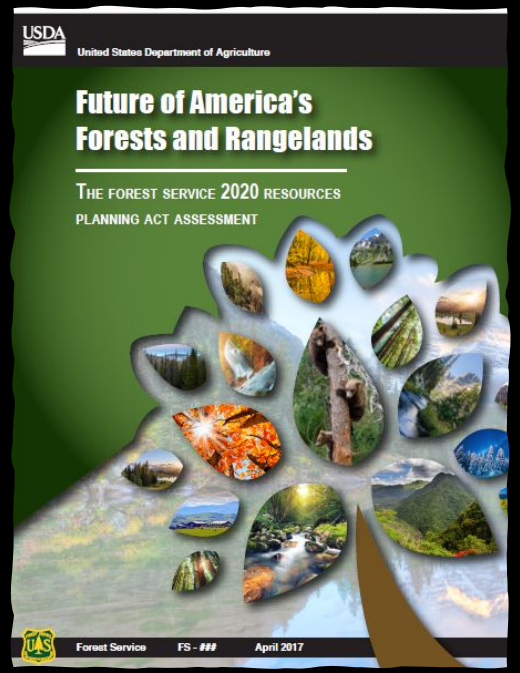
Forest Service

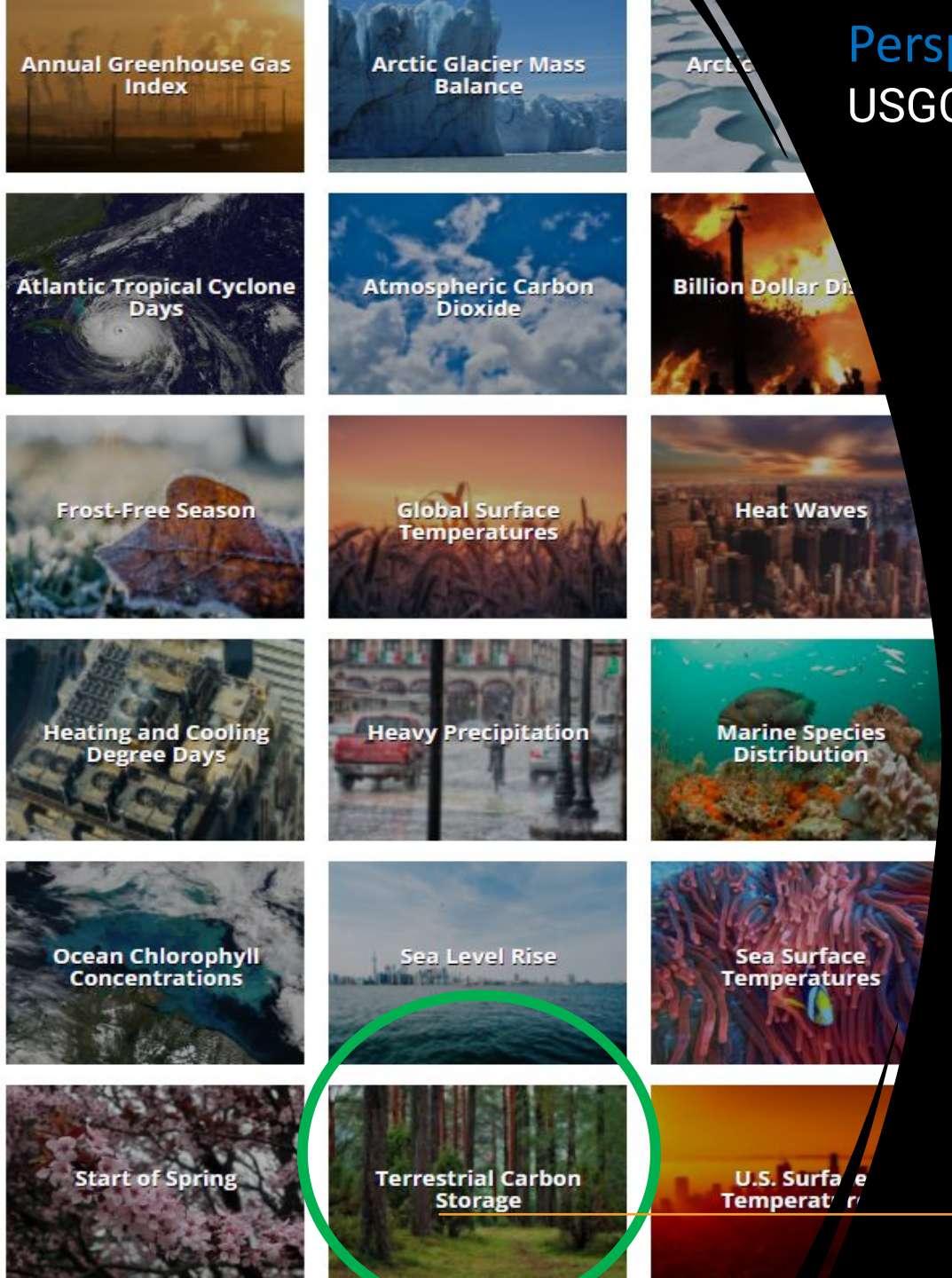
My Perspective

- USDA USFS Forest Inventory & Analysis (FIA) Program
  - provide information to Assess America's forests through statistical surveys (Field, Mill and Owner surveys)
- Forest Disturbance and Vegetation mapping Specialist
- Co-Agency collaborator (cross pollinator)



  - MRLC ; Science lead USFS NLCD Tree Canopy Cover
  - LANDFIRE ; FIA Liaison aid integration and innovation with FIA & NRCS plot data
  - USFS International Programs
  - USFS Resource Planning Act Assessment – disturbance chapter





Perspective

USGCRP Indicators Catalog & Forests

GCRA **mandates** that USGCRP prepare and submit to the President and the Congress a quadrennial assessment, referred to as the National Climate Assessment (NCA), which:

- Integrate[s], evaluate[s], and interpret[s] the findings of the Program and discuss[es] the scientific uncertainties associated with such findings
- Analyze[s] the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity
- Analyze[s] current trends in global change, both human-induced and natural, and project[s] major trends for the subsequent 25 to 100 years

scientific uncertainties

Social services

human health and welfare

biological diversity

Climate/env. services

land and water resources

trends in global change,
both human-induced and natural

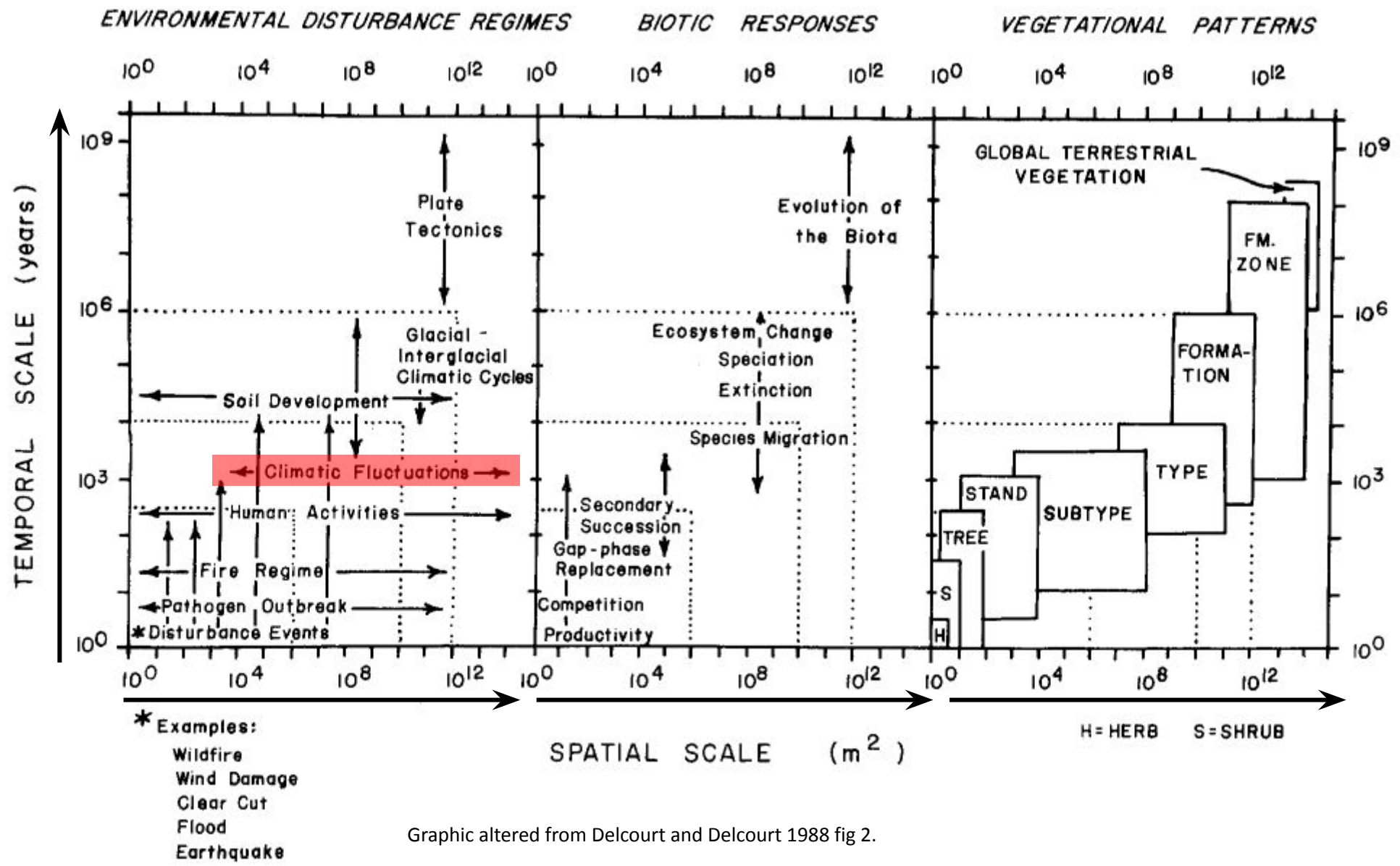
Economic services

agriculture (subset :forestry sector)

effects of global change on the
natural environment

Forest Processes – Scale of the observation must be commensurate with the scale of the process [*Levin*, 1992] [*Wu and Loucks*, 1995]

Disturbance regimes – Biotic responses (forest condition and health) – Vegetational patterns (Land Cover)



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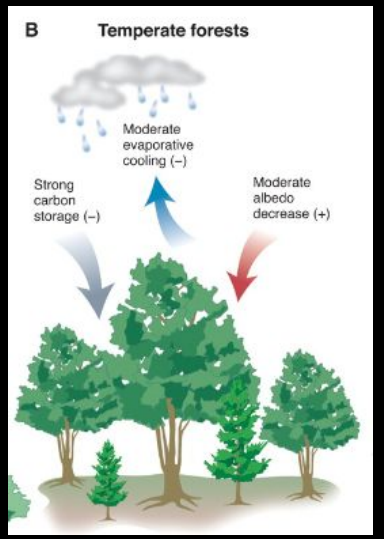
Perspective

What are the scale of the phenomena of interest ?

- Climate/env. services
- Social services
- Economic services

What are the scale of observations available?



Observations

(operational)

Observations of Vegetational patterns – Forest Land Cover

- what observations are missing to make better forecasts, indicators, applications, etc?

National (RS based)

- NLCD (2001:2011-2021) - Landsat
- LCMAP (1985-2021) - Landsat
- LANDFIRE (2001-2020) * - Landsat
- LCMS (1985-2021) – Landsat

Global (RS based)

- GLAD (30m) - Landsat
- Dynamic World (10m- Sentinel) (2013-2021) 9 classes

National US Surveys

- FIA – national field plot survey on all lands (2001*-current)

Gaps

(operational)

Vegetational patterns –

- what observations are missing to make better forecasts, indicators, applications, etc?

National & Global RS products

- Improved Thematic depth
  - Lifeform Definition Standards ?
    - Anderson level 11 definitions usually a combination of life form, height and % cover
    - Most RS products now producing some form of % cover by lifeform But lifeform definitions don't share standards across products
  - Clear separation of Land Use and Land Cover ?
  - Limited Biotic information
  - Limitations of structural information (largely derived from optical sensors)
  - Forest Condition & Forest Health
- Errors and Accuracy Reporting
  - Categorical - *if* reported usually tabular and tied to reporting or modeling area – not tied to scale of observation (pixel/s)
  - Spatial – *often* none
- Uncertainty
  - Lots of room for improvement

Land Use or Land Cover

Agriculture	Crops / Fallow
Forestry	Tree / Bare Ground
Developed	Impervious / Canopy over Imp.

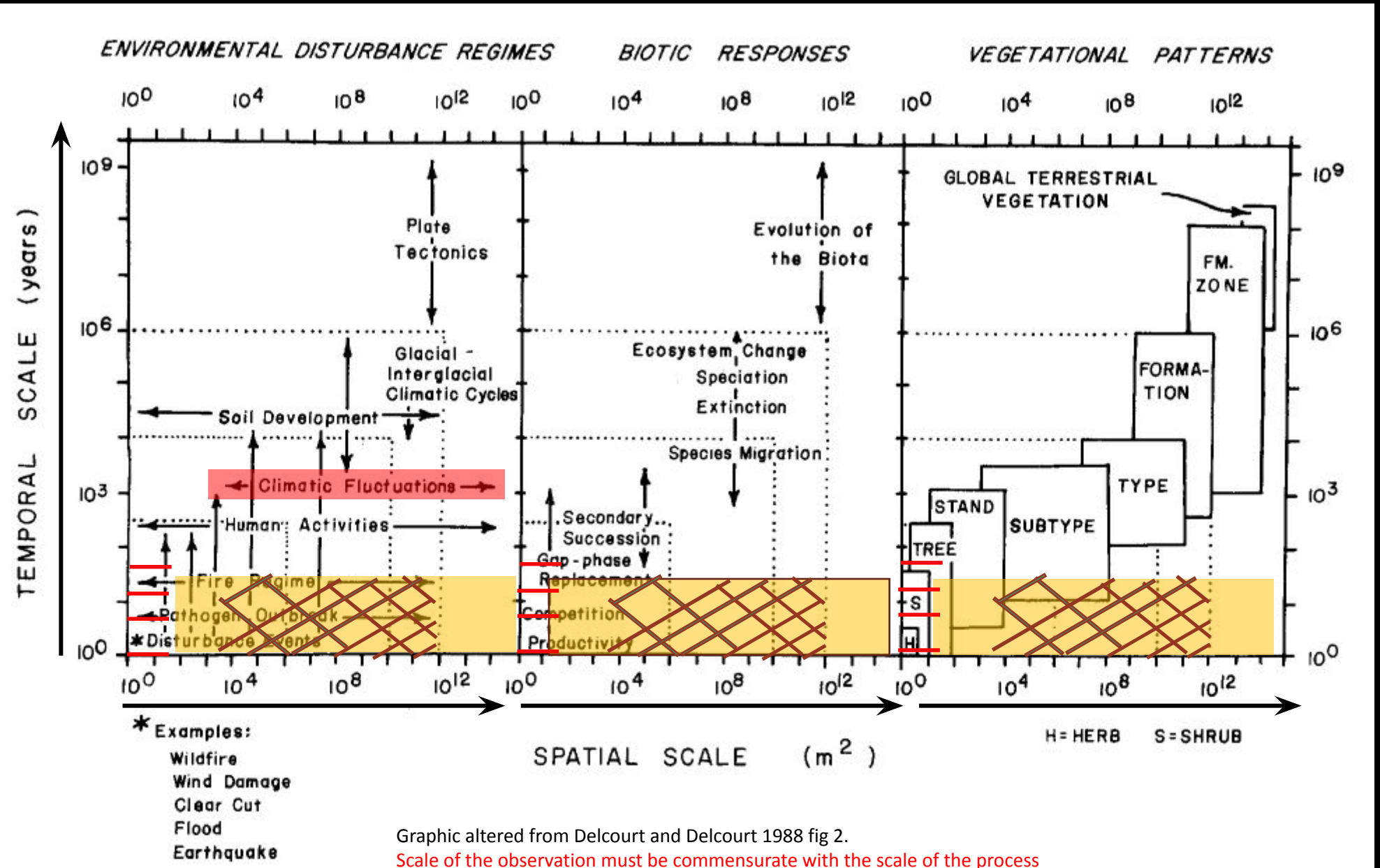
Climate/env. services

Social services

Economic services

Gaps

orange box - “modern” strategic RS products ; red lines = field plots ; brown hatches = estimation from surveys.
Improving RS, field surveys, and computing capacity will determine future quality of observations.



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Scale of the observation must be commensurate with the scale of the process

Perspective

What are the scale of the phenomena of interest ?

What are the scale of observations ?

Gaps

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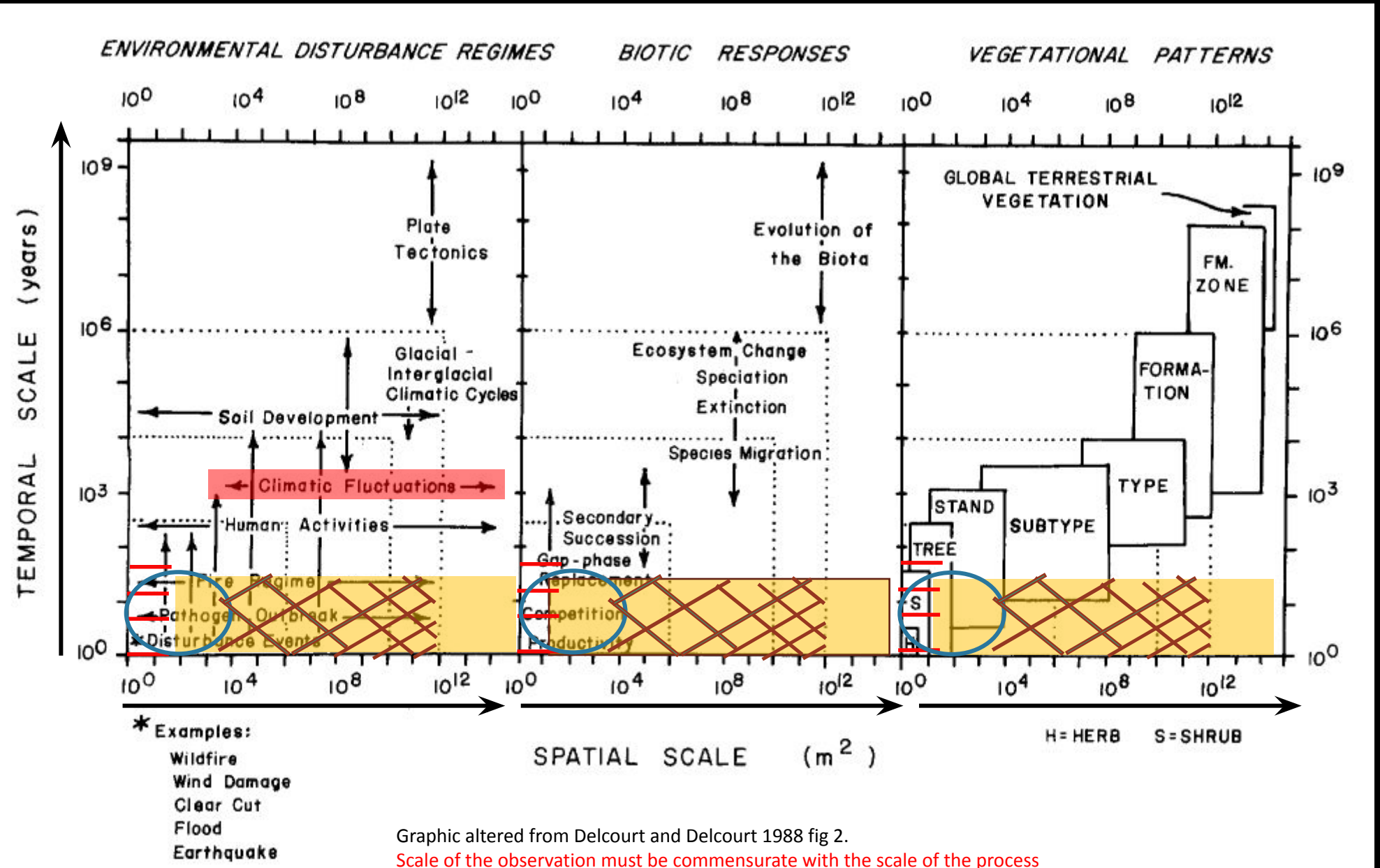

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Scale of the observation must be commensurate with the scale of the process

Perspective

What are the scale of the phenomena of interest ?

What are the scale of observations ?

Small Area Estimation

Gaps

(operational)

Vegetational patterns – Forest Land Cover

- what observations are missing to make better forecasts, indicators, applications, etc?

National FIA Statistical Survey - how much forest exists on the landscape, where it exists, what kinds of trees are growing in the forest, who owns the forestland, how it is changing, how the trees and other forest vegetation are growing, and how much has died or been removed in recent years….

- Spatial & Temporal Resolution of plot sample
  - Spatially can be augmented but up to discretion of funding partnerships
  - Temporal resolution varies across the country

- Field plots on Forest land Use only
  - Trees outside of forest land ?

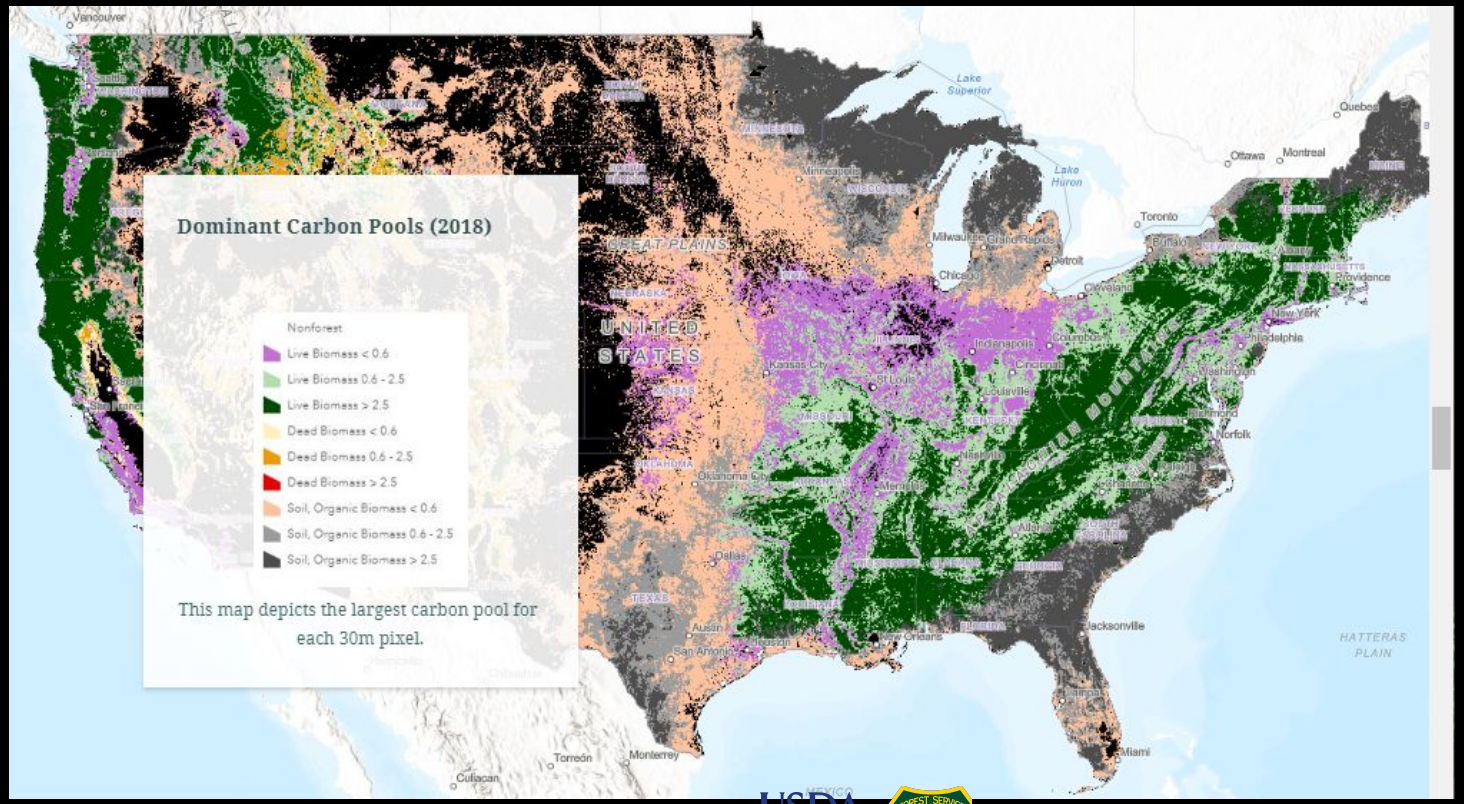
- Estimation
  - High Uncertainty –high in small area estimation or potentially for rare classes
    - Designed for strategic inventories (state/county) with known standards of precision

What has changed since NCA4 (2018)? Were observational gaps filled that were identified in this earlier report? Are we working to address the observing gaps from that report?

Pixel

New operational wall to wall annual Cover products

- LCMS (USFS)
- LCMAP (USGS)

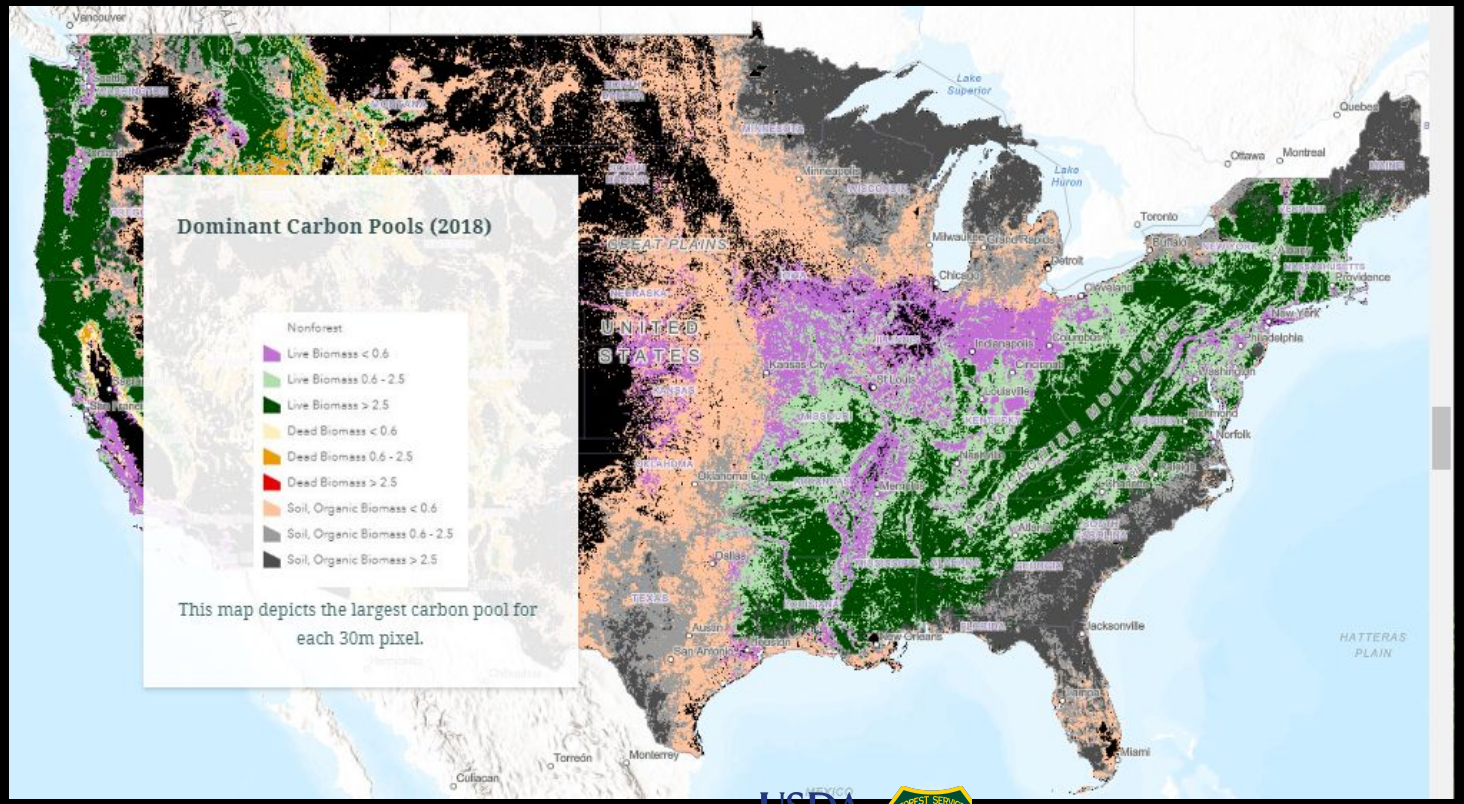


BIGMAP story maphttps://storymaps.arcgis.com/stories/c710684b93544[illegible]e8960d37905b2

Field plot + Pixel

New operational wall to wall products forest type and conditions products

- BIGMAP (USFS)
- LANDFIRE – US National Classification Standards – Group level



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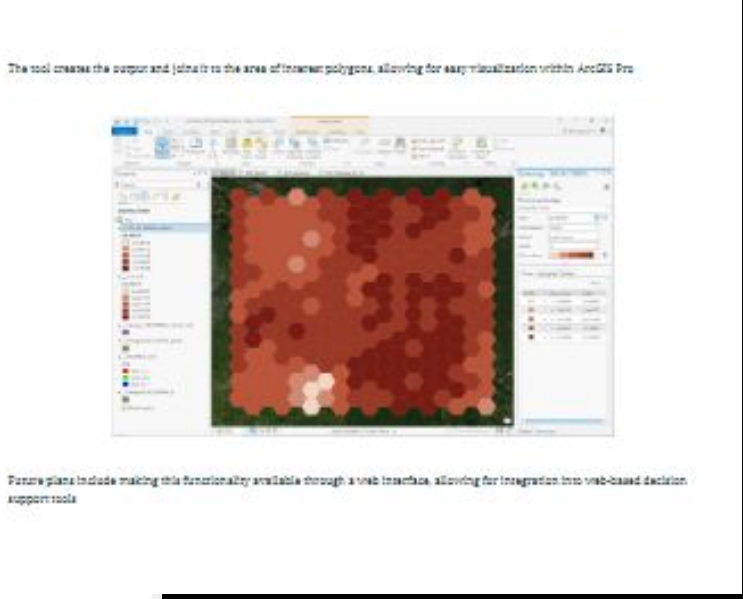
Field plot + Pixel

More Support for Small Area estimation using FIA and RS ancillary data



The tool creates the output and joins it to the area of interest polygons, allowing for easy visualization within ArcGIS Pro

Future plans include making this functionality available through a web interface, allowing for integration into web-based decision support tools

USDA The Forest Inventory & Analysis Geospatial Data Showcase

Data

CONUS TOTAL FOREST CARBON (2014-2018)

CONUS FOREST CARBON POOLS (2014-2018)

CONUS FOREST TYPE GROUPS (2014-2018)

CONUS FOREST STOCKING (2014-2018)

LOREY'S HEIGHT (CONUS - 2014-2018)

STAND AGE (CONUS - 2014-2018)

BIGMAP story maphttps://storymaps.arcgis.com/stories/c710684b98544[illegible]e8960d37905b2

integrating into climate modeling frameworks

- New age of remote sensing – beyond passive sensors –
  - Breakthroughs in forest biomass-carbon information
  - Fuels and fire behavior models

- Spaceborne lidar :
  - GEDI – in process of combining in- depth localized information and satellite data fusion with Landsat/Sentinel/Radar systems.
  - OBI-WAN - Small Area Estimation of Biomass leveraging statistical estimators to support UNFCC and REDD+ for tier 3 estimates. 1km

- Leveraging National airborne lidar acquisitions
  - Urban
  - High resolution digital aerial photogrammetry – NAIP and others
  - For vegetation structure mapping,
  - Fuels for fire behavior models

References for OBI-WAN
Healey, S. P., Yang, Z., Gorelick, N., & Ilyushchenko, S. (2020). Highly Local Model Calibration with a New GEDI LiDAR Asset on Google Earth Engine Reduces Landsat Forest Height Signal
Saturation. Remote Sensing, 12(17), 2840
Patterson, Paul L., et al. "Statistical properties of hybrid estimators proposed for GEDI—NASA's global ecosystem dynamics investigation." Environmental Research Letters 14.6 (2019): 065007.
Saarela, S., Holm, S., Healey, S. P., Andersen, H. E., Petersson, H., Prentius, W., ... & Ståhl, G. (2018). Generalized hierarchical model-based estimation for aboveground biomass assessment using GEDI
and Landsat data. Remote Sensing, 10(11), 1832.

bservational gaps filled that were identified in this earlier report?

Observational needs :

- Forest Sustainability
- Forest Productivity

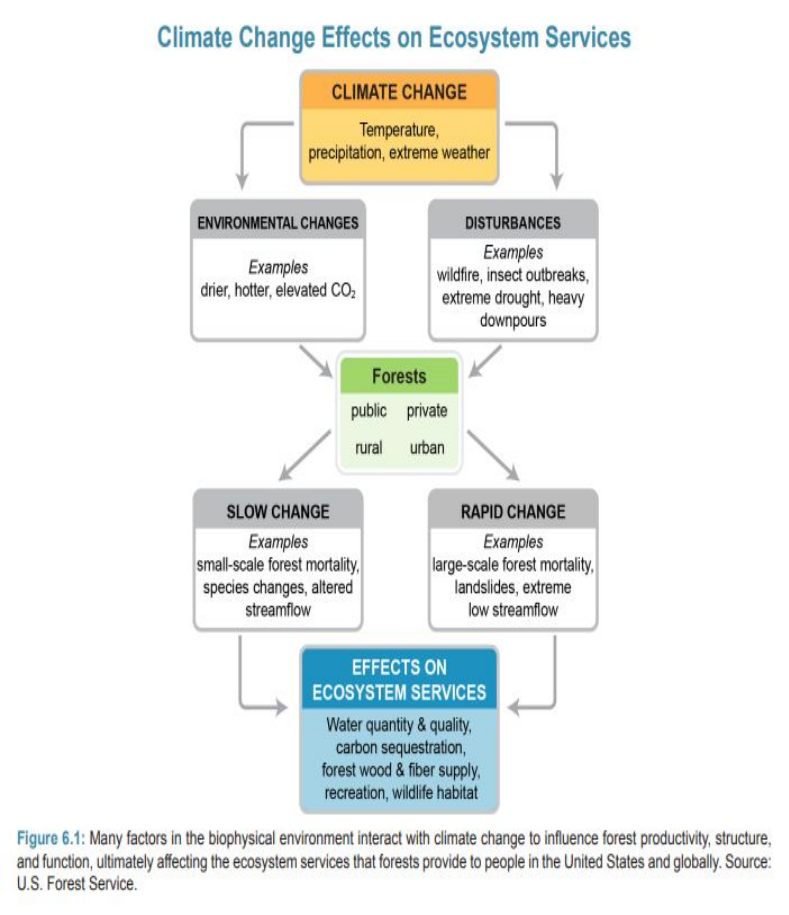
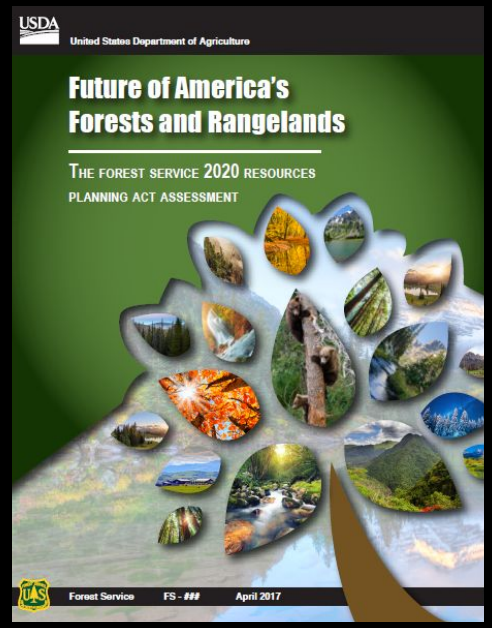


Figure 6.1: Many factors in the biophysical environment interact with climate change to influence forest productivity, structure, and function, ultimately affecting the ecosystem services that forests provide to people in the United States and globally. Source: U.S. Forest Service.

- Ecological Disturbance and Forest Health Uncertainties :
  - Predicting wildfire frequency and extent, especially at smaller than regional scales.
  - Scientific info on climate changes effect on Fungal pathogens – projections of disease uncertain, (especially in magnitude).
  - Species dist and abundance changes in relation to climate change… magnitude, geographic specificity and rate are uncertain.
- Ecosystem Services Uncertainties :
  - Projections… especially at fine scales : climate -> disturbance -> forest cover -> socioeconomics
  - uncertainties related to future land-use conversions (from forests to other uses and vice versa) and the production of wood products.
- Forest management activities Uncertainties :
  - Physical and biological conditions of ecosystems are constantly changing, complex interactions among stressors, could lead to unforeseen outcomes… Thus, the long-term effectiveness of adaptation actions for increasing forest resistance and resilience to climate change is uncertain until a sufficient time series of monitoring data is available, requiring decades of observations.
  - Pace of adaptation and barriers to implementation uncertain… hard to predict how society and orgs will respond.

Projections… especially at fine scales : climate -> disturbance -> forest cover -> socioeconomics

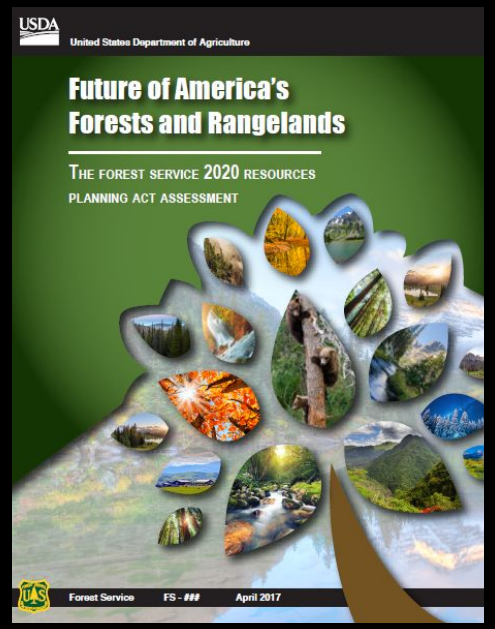


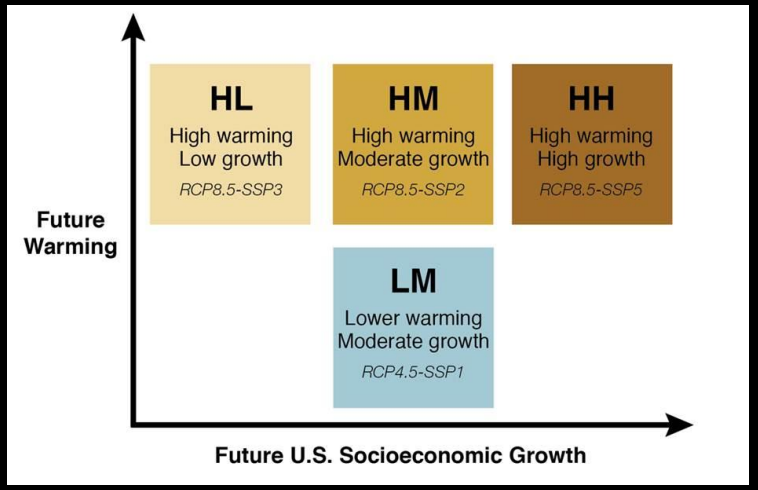
RPA reports on the current conditions and trends of renewable resources **on all forest and rangelands**

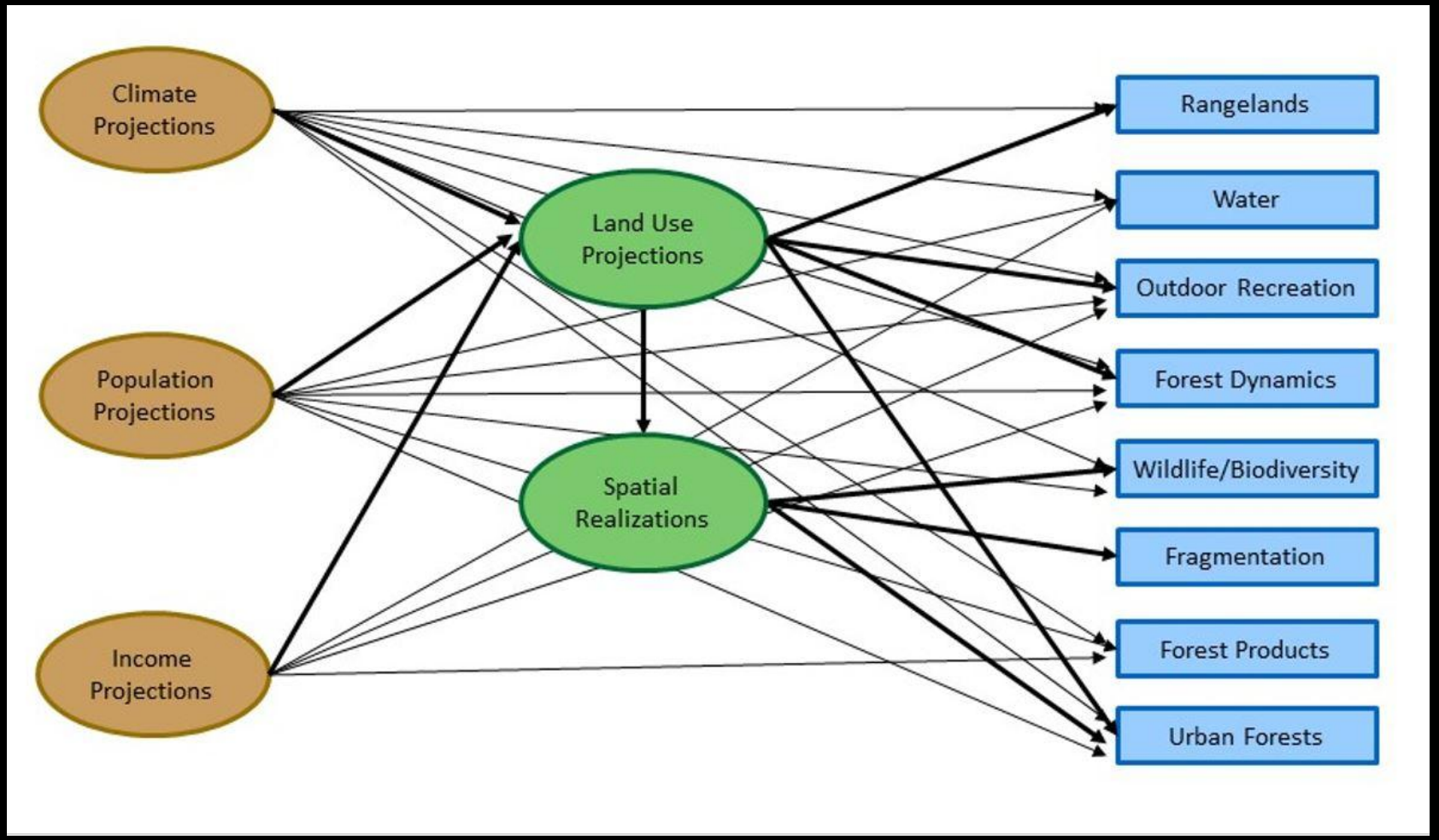
RPA Scenario *(RCP-SSP)*	Global Temperature Rise	U.S. Population Growth	U.S Economic Growth Rate	Bioenergy Demand	Energy Sector Focus	Global Energy Usage	International Trade Openness
LM Lower warming Moderate growth *RCP4.5-SSP1*	Lower	Medium	Medium-High	High	Renewables	Low	Medium
HL High warming Low growth *RCP8.5-SSP3*	High	Low	Low	Low	Fossil fuels	Medium	Low
HM High warming Moderate growth *RCP8.5-SSP2*	High	Medium	Medium	Medium	Mixed	Medium	Medium
HH High warming High growth *RCP8.5-SSP5*	High	High	High	High	Fossil fuels	High	High

How does interaction of economic, social, and biophysical factors affect the productivity of forest and rangeland ecosystems and their ability to meet increasing demands for goods and services ?

Projections… especially at fine scales : climate -> disturbance -> forest cover -> socioeconomics







Down scaled climate projects –>county level land use ->90 m Spatial Realizations

Observational needs :

- Forest Sustainability
- Forest Productivity

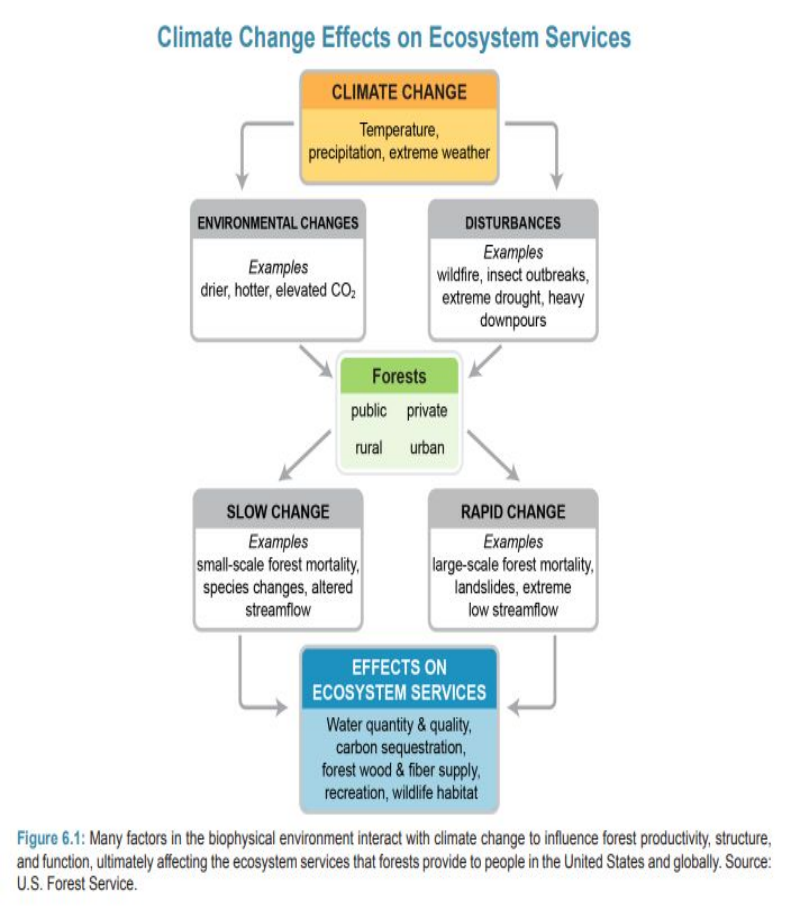


Figure 6.1: Many factors in the biophysical environment interact with climate change to influence forest productivity, structure, and function, ultimately affecting the ecosystem services that forests provide to people in the United States and globally. Source: U.S. Forest Service.

Additional Uncertainties

- (forest) Interconnections among urban systems …. in quantifying combined impacts and natural feedbacks

- Models that predict priors – not pandemics
  - Price of timber and impact on forestry sector workforce.
  - weak timber markets mean reduced incentives for private forest owners to actively manage forests in ways that enhance climate resilience.

What decisions have been made on the ground using high quality observations in your area of expertise?

FIA data -> LANDFIRE -> USFS FIRE LAB -> TREE MAP ->project based LIDAR ->3d fire and fuel models for first order fire effects predictions

TreeMap: A tree-level model of conterminous U.S. forests

Description

Abstract

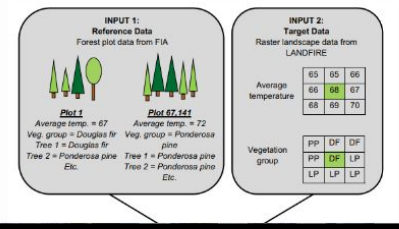
TreeMap provides a 30x30m-resolution gridded dataset of forest plot identifiers for the conterminous United States. Forest plots from the USDA Forest Service Forest Inventory and Analysis program (FIA) were imputed to gridded c2014 landscape data provided by the LANDFIRE project using topographic, biophysical, and disturbance variables. The output consisted of a raster map of plot identifiers. From the plot identifiers, users of the dataset can link to a number of tree- and plot-level attributes stored in the accompanying tables and in the publicly available FIA DataMart, and then produce maps of any of these attributes, including number of trees per acre, tree species, and forest type.

Purpose

TreeMap was developed to help evaluate wildfire risks to forest carbon. It may also have broader relevance for analyzing carbon dynamics, habitat distributions, and effects of fire and forest management projects, among other applications. It has also been applied to develop snag hazard maps for active fire incidents.

Inputs

To develop TreeMap, forest plots from the Forest Inventory and Analysis program (FIA) were imputed to gridded c2014 landscape data provided by the LANDFIRE project. The FIA database contains tree-level information from thousands of plots across the United States, but the plots don't provide wall-to-wall coverage. The LANDFIRE project provides a 30x30 meter grid of



Riley, Karin L.; Grenfell, Isaac C.; Finney, Mark A.; Wiener, Jas
M. 2019. Fire Lab tree list: A tree-level model of the conterminc
landscape circa 2014. Fort Collins, CO: Forest Service Research Data
Archive. https://doi.org/10.2737/RDS-2019-0026

Modeling fuels and fire effects in 3D: Model description and applications

François Pimont [a,*], Russell Parsons [b], Eric Rigolot [a], François de Coligny [c], Jean-Luc Dupuy [a], Philippe Dreyfus [e], Rodman R. Linn [d]

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